Nevada Test Site

U1a Complex
Subcritical Experiments

February 2003

Introduction

The U1a Complex is an underground laboratory of horizontal tunnels about one-half mile in length mined at the base of a vertical shaft approximately 960 feet beneath the surface. The vertical shaft is equipped with a mechanical hoist for personnel and equipment access while another vertical shaft about 1,000 feet away provides cross ventilation, instrumentation, and utility access and emergency egress. On the surface, there are several temporary buildings and instrumentation trailers. The explosive assemblies for the experiments are placed in small, permanently sealed alcoves mined in the sidewalls of the underground U1a Complex. The Complex provides a high degree of safety for Nevada Test Site workers and the public and minimizes environmental impacts. The shaft was originally excavated in the 1960's, and a nuclear test was conducted in a horizontal tunnel mined from its base in 1990.

Aerial view of the U1a Complex.

Subcritical Experiments are scientific experiments to obtain technical information in support of the U.S. Department of Energy, National Nuclear Security Administration's (NNSA) Stockpile Stewardship and Management Programs -- the NNSA programs are to maintain the safety and reliability of the U.S. nuclear weapons stockpile without nuclear testing. They involve chemical high explosives to generate high pressures that are applied to nuclear weapon materials, such as plutonium. The configuration and quantities of explosives and nuclear materials will be such that no nuclear explosion will take place. Thus, the experiments are consistent with the Comprehensive Test Ban Treaty. They are called "subcritical" because there will be no critical mass formed, i.e., no self-sustaining nuclear fission chain reaction will occur. Scientific data is obtained on the behavior of nuclear weapon materials by the use of complex, high speed measurement instruments.

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The First Experiments

Los Alamos National Laboratory conducted the first subcritical experiment *Rebound* on July 2, 1997. The purpose of the experiment was to obtain information on the response of plutonium to shock wave compression at different pressures. This information was obtained by performing fundamental shock wave experiments on plutonium. This data is a *hugoniot curve*, that is, a curve showing density.

Rebound involved three measurements of different pressures, which were done in a single experiment room, 10 feet by 15 feet by 30 feet, located 962 feet below ground in the U1a Complex. All three of the experiments utilized high explosives for driving stainless-steel flyer plates into target assemblies generate pressure in the plutonium targets.

The second subcritical experiment *Holog* was conducted by Lawrence Livermore National Laboratory scientists on September 18, 1997. It was designed to yield information on the nonnuclear properties of plutonium under extreme shock conditions.

The name *Holog* was taken from the Laboratory-developed holography technology that allows scientists to capture three-dimensional images of the particles ejected from the surface of materials shocked by high explosives.

The *Holog* experiment was to allow scientists to answer basic questions like how plutonium reacts when shocked -- which cannot be determined today with the required precision by experimenting with substitute materials. It is anticipated that this data will be used in complex computer simulations which will help assure the safety and reliability of U.S. nuclear weapons without nuclear testing.

The explosion was comparable to that of a large fire cracker or shotgun blast.

The object of the experiment was to characterize the *ejecta cloud.* Information about the mass, particle size distribution, and mass velocity distribution will allow scientists to understand more clearly the properties of shocked plutonium. Images were then analyzed by computer to obtain measurements of particle size distribution, and particle size and speed relationships. Other diagnostic tools used included ultra fast framing cameras, able to record 100 frames per microsecond (1/1,000,000th of a second), and a Fabry-Perot Velocimeter (which measures the speed of machinery, projectiles or sound) to measure how fast the surface of a plutonium plate moved when shocked.

Future Experiments

While it is always difficult to forecast into the future, both laboratories have long-range plans to continue their respective subcritical experiments, information from which will play a large role in ensuring the safety and reliability of the nation's nuclear stockpile.

Experiments Conducted To Date

Rebound	July 2, 1997 (LANL)
Holog	September 18, 1997 (LLNL)
Stagecoach	March 25, 1998 (LANL)
Bagpipe	September 26, 1998 (LLNL)
Cimarron	December 11, 1998 (LANL)
Clarinet	February 9, 1999 (LANL)
Oboe 1	September 30, 1999 (LLNL)
Oboe 2	November 9, 1999 (LLNL)
Oboe 3	February 3, 2000 (LLNL)
Thoroughbred	March 22, 2000 (LANL)
Oboe 4	April 6, 2000 (LLNL)
Oboe 5	August 18, 2000 (LLNL)
Oboe 6	December 14, 2000 (LLNL)
Oboe 8	September 26, 2001 (LLNL)
Oboe 7	December 13, 2001 (LLNL)
Vito	February 14, 2002 (LANL)*
Oboe 9	June 7, 2002 (LLNL)
Mario	August 29, 2002 (LANL)
Rocco	September 26, 2002 (LANL)

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** Vito was conducted in conjunction with the United Kingdom's Atomic Weapons Establishment*